ment of the fine particles during drive, and thus can be an electron-emitting device that is stable and of elongated life.

The electron emission efficiency can be improved by suitably adjusting the density of the fine particles.

The electron-emitting device having the semiconductor layer as illustrated in FIG. 17 makes it possible to lower the drive voltage by controlling the electrical resistance of the semiconductor, and also can be effective in improvement of emitted currents.

We claim:

1. A method of preparing an electron-emitting device, comprising the steps of:

forming electrodes opposed to each other on a substrate;

forming between the electrodes and in contact therewith an insulating layer in which fine particles are completely enclosed; and

etching the insulating layer so as to partially expose the fine particles.

2. A method of preparing an electron-emitting device comprising the steps of:

forming electrodes opposed to each other on a substrate;

forming between the electrodes and in contact therewith a semiconductor layer in which fine particles are completely enclosed; and

etching the semiconductor layer so as to partially expose the fine particles.

3. A method of preparing an electron-emitting device, comprising the steps of:

(i) forming a semiconductor layer on a substrate;

(ii) forming electrodes on said semiconductor layer; and

(iii) dispersing fine particles between said electrodes.

4. The method of claim 3, wherein said semiconductor layer comprises a layer comprising an amorphous silicon semiconductor, a crystallized silicon semiconductor, or a compound semiconductor.

5. The method of claim 3, wherein said semiconductor layer has a film thickness of from 50 angstroms to 10 μm.

* * * * *

6. A method of fabricating an electron-emitting device which comprises a pair of electrodes and a layer disposed between the electrodes, the method comprising the steps of:

disposing the pair of electrodes in first and second regions on a substrate, respectively; and

providing the layer between the regions, the layer comprising a metal and a semiconductor.

7. The method of Claim 6, wherein the metal is Pd.

8. The method of Claim 6 or 7, wherein the semiconductor is selected from the group consisting of carbon and SnO_2.

9. A method of fabricating an electron-emitting device, comprising the steps of:

disposing a pair of electrodes in first and second regions on a substrate, respectively; and

providing a layer between the regions, the layer comprising carbon and a metal.

10. The method of Claim 9, wherein the metal is Pd.

11. The method of Claim 9, wherein the layer comprises primarily carbon.

12. A method of fabricating an electron-emitting device, comprising the steps of:

disposing a pair of electrodes in first and second regions on a substrate, respectively; and

providing a layer between the regions, the layer comprising an insulating material and at least some conductive particles which protrude from a surface of the layer.

13. The method of Claim 12, wherein the conductive particles comprise a material selected from the group consisting of a metal, a semi-metal, and a semiconductor.

14. The method of Claim 13, wherein the semiconductor is SnO_2.

15. The method of Claim 12, 13, or 14, wherein the insulating material is SiO_2.

16. A method of fabricating an electron-emitting device, comprising the steps of:

disposing a pair of electrodes in first and second regions on a substrate, respectively; and

providing a layer between the regions, the layer comprising carbon and at least some conductive particles.

17. The method of Claim 16, wherein the layer comprises primarily carbon.

18. The method of Claim 17, wherein the conductive particles comprise a material selected from the group consisting of a metal, a semi-metal, and a semiconductor.

19. The method of Claim 13, wherein the metal is Pd.

20. The method of any one of Claims 16-19, wherein at least some of the conductive particles protrude from a surface of the layer.

21. The method of any one of Claims 12-14 and 16-19, wherein the conductive particles are spatially separated from one another.

22. The method of any one of Claims 12-14 and 16-19, wherein diameters of the conductive particles are in a range of several tens of angstroms to several micrometers.

23. A method of fabricating an electron-emitting device, comprising the steps of:

forming an insulating layer on a first portion of a surface of a substrate, so as to define a step-like structure;

disposing a first electrode on a second portion of the surface of the substrate;

disposing a second electrode on an upper surface of the insulating layer; and

providing a layer along a side of the insulating layer, between the first and second electrodes, the layer comprising a metal and a semiconductor.

24. The method of Claim 23, wherein the side of the insulating layer includes a surface which is substantially

perpendicular to the surface of the substrate, and the layer is provided on that surface.

25. The method of Claim 23 or 24, wherein part of the insulating layer also is formed on a portion of the first electrode.

26. The method of Claim 23 or 24, wherein the metal is Pd.

27. The method of Claim 26, wherein the semiconductor is carbon.

28. A method of fabricating an electron-emitting device, comprising the steps of:

forming an insulating layer on a first portion of a surface of a substrate, so as to define a step-like structure;

disposing a first electrode on a second portion of the surface of the substrate;

disposing a second electrode on an upper surface of the insulating layer; and

providing a layer along a side of the insulating layer, between the first and second electrodes, the layer comprising an insulating material and a conductive material.

29. The method of Claim 28, wherein the side of the insulating layer includes a surface which substantially perpendicular to the surface of the substrate, and the layer is provided on that surface.

30. The method of Claim 28 or 29, wherein part of the insulating layer also is formed on a portion of the first electrode.

31. The method of Claim 28 or 29, wherein the conductive material is selected from the group consisting of Pd and SnO_2.

32. The method of Claim 31, wherein the insulating material is SiO_2.

33. A method of fabricating an electron-emitting device, comprising the steps of:

forming an insulating layer on a first portion of a surface of a substrate, so as to define a step-like structure;

disposing a first electrode on a second portion of the surface of the substrate;

disposing a second electrode on an upper surface of the insulating layer; and

providing a layer along a side of the insulating layer, between the first and second electrodes, the layer including carbon and at least some conductive particles.

34. The method of Claim 33, wherein the layer comprises primarily carbon.

35. The method of Claim 33 or 34, wherein the conductive particles include Pd.

36. A method of fabricating an electron source that includes a plurality of electron-emitting devices, each electron-emitting device comprising a pair of electrodes and a layer disposed between the electrodes, wherein each electron-emitting device is prepared by a method comprising the steps of:

disposing the pair of electrodes in first and second regions on a substrate, respectively; and

providing the layer between the regions, the layer comprising a metal and a semiconductor.

37. A method of fabricating an electron source that includes a plurality of electron-emitting devices, each electron-emitting device being prepared by a method comprising the steps of:

disposing a pair of electrodes in first and second regions on a substrate, respectively; and

providing a layer between the regions, the layer comprising carbon and a metal.

38. A method of fabricating an electron source that includes a plurality of electron-emitting devices, each electron-emitting device being prepared by a method comprising the steps of:

disposing a pair of electrodes in first and second regions on a substrate, respectively; and

providing a layer between the regions, the layer including an insulating material and at least some conductive

particles, wherein at least some of the conductive particles protrude from a surface of the layer.

39. A method of fabricating an electron source that includes a plurality of electron-emitting devices, each electron-emitting device being prepared by a method comprising the steps of:

forming an insulating layer on a first portion of a surface of a substrate, so as to define a step-like structure;

disposing a first electrode on a second portion of the surface of the substrate;

disposing a second electrode on an upper surface of the insulating layer; and

providing a layer along a side of the insulating layer, between the first and second electrodes, the layer comprising a metal and a semiconductor.

40. A method of fabricating an electron source that includes a plurality of electron-emitting devices, each electron-emitting device being prepared by a method comprising the steps of:

forming an insulating layer on a first portion of a surface of a substrate, so as to define a step-like structure;

disposing a first electrode on a second portion of the surface of the substrate;

disposing a second electrode on an upper surface of the insulating layer; and

providing a layer along a side of the insulating layer, between the first and second electrodes, the layer comprising an insulating material and a conductive material.

41. A method of fabricating an electron source that includes a plurality of electron-emitting devices, each electron-emitting device being prepared by a method comprising the steps of:

forming an insulating layer on a first portion of a surface of a substrate, so as to define a step-like structure;

disposing a first electrode on a second portion of the surface of the substrate;

disposing a second electrode on an upper surface of the insulating layer; and

providing a layer along a side of the insulating layer, between the first and second electrodes, the layer including carbon and at least some conductive particles.

42. A method of fabricating an image forming apparatus which includes an electron source and a phosphor plate, the electron source including plurality of electron-emitting devices that are each prepared by a method according to any one of Claims 36-41.

43. A method of fabricating an electron-emitting device which comprises a pair of electrodes and a layer disposed between the electrodes, the method comprising the steps of:

disposing a pair of electrodes in first and second regions on a substrate, respectively; and

providing the layer between the regions, the layer being a semiconductor layer that includes a metal.

44. The method of Claim 43, wherein the metal is Pd.

45. The method of Claim 43 or 44, wherein the semiconductor layer includes a semiconductor selected from the group consisting of carbon and SnO_2.

46. A method of fabricating an electron-emitting device, comprising the steps of:

disposing a pair of electrodes in first and second regions on a substrate, respectively; and

providing a layer between the regions, the layer being an insulating layer which includes at least some conductive particles, wherein at least some of the conductive particles protrude from a surface of the layer.

47. The method of Claim 46, wherein the conductive particles include a material selected from the group consisting of a metal, a semi-metal, and a semiconductor.

48. The method of Claim 47, wherein the semiconductor is SnO_2.

49. A method of fabricating an electron-emitting device, comprising the steps of:

forming an insulating layer on a first portion of a surface of a substrate, so as to define a step-like structure;

disposing a first electrode on a second portion of the surface of the substrate;

disposing a second electrode on an upper surface of the insulating layer; and

providing a layer along a side of the insulating layer, between the first and second electrodes, the layer being a semiconductor layer which includes a metal.

50. A method of fabricating an electron-emitting device, comprising the steps of:

forming an insulating layer on a first portion of a surface of a substrate, so as to define a step-like structure;

disposing a first electrode on a second portion of the surface of the substrate;

disposing a second electrode on an upper surface of the insulating layer; and

providing a layer along a side of the insulating layer, between the first and second electrodes, the layer being an insulating layer which includes a conductive material.

51. A method of fabricating an electron source that includes a plurality of electron-emitting devices, each electron-emitting device being prepared by a method comprising the steps of:

disposing a pair of electrodes in first and second regions on a substrate, respectively; and

providing a layer between the regions, the layer comprising carbon and at least some conductive particles.

52. A method of fabricating an electron source that includes a plurality of electron-emitting devices, each electron-emitting device comprising a pair of electrodes and a layer disposed between the electrodes, each electron-emitting device being prepared by a method comprising the steps of:

disposing a pair of electrodes in first and second regions on a substrate, respectively; and

providing the layer between the regions, the layer being a semiconductor layer which includes a metal.

53. A method of fabricating an electron source that includes a plurality of electron-emitting devices, each electron-

emitting device being prepared by a method comprising the steps of:

disposing a pair of electrodes in first and second regions on a substrate, respectively; and

providing a layer between the regions, the layer being a carbon layer which includes a metal.

54. A method of fabricating an electron source that includes a plurality of electron-emitting devices, each electron-emitting device being prepared by a method comprising the steps of:

disposing a pair of electrodes in first and second regions on a substrate, respectively; and

providing a layer between the regions, the layer being an insulating layer which includes at least some conductive particles, wherein at least some of the conductive particles protrude from a surface of the layer.

55. A method of fabricating an electron source that includes a plurality of electron-emitting devices, each electron-emitting device being prepared by a method comprising the steps of:

forming an insulating layer on a first portion of a surface of a substrate, so as to define a step-like structure;

disposing a first electrode on a second portion of the surface of the substrate;

disposing a second electrode on an upper surface of the insulating layer; and

providing a layer along a side of the insulating layer, between the first and second electrodes, the layer being a semiconductor layer which includes a metal.

56. A method of fabricating an electron source that includes a plurality of electron-emitting devices, each electron-emitting device being prepared by a method comprising the steps of:

forming an insulating layer on a first portion of a surface of a substrate, so as to define a step-like structure;

disposing a first electrode on a second portion of the surface of the substrate;

disposing a second electrode on an upper surface of the insulating layer; and

providing a layer along a side of the insulating layer, between the first and second electrodes, the layer being an insulating layer which includes a conductive material.

57. A method of fabricating an image forming apparatus which includes an electron source and a phosphor plate, the electron source including a plurality of electron-emitting devices that are each prepared by a method according to any one of Claims 51-56.

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